International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Comparative Study of Heat Transfer Rate between General Water and Distilled Water

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Abstract: ***The main objective is to compare the heat transfer rate between two fluids, i.e. general water and distilled water. Here we conduct the heat produce by solar radiation, in this project we are using parabolic trough concentrating collector for the heat transfer. The cost of the parabolic trough is generally less as compare to others. The main objective of using parabolic trough is to concentrate the solar rays onto the absorbing copper tube. Absorbing copper tube is used to collect the solar radiations and transfer the heat generated from it to fluid flowing inside it.***

Keywords: Parabolic concentrating trough, Absorbing copper tube, General water, distilled water

1. Introduction

Today the main aim of all the countries is to develop energy from different sources; these sources are generally categorized in earning type and non earning type sources. Earning type sources generally consist of use of petroleum products, nuclear power and hydro- power etc. and non earning type sources consist of wood which we get from trees, animal and human waste and agricultural type of waste. Developed countries like USA are generally depends on fossil fuels and under developing countries like INDIA are depends on both earning and non earning type fuels. In the past few years, earning type of fuels i.e. fossil fuel resources are fast depleting and that the fossil fuel era is gradually coming to end. Therefore the non conventional energy sources like sun, tidal, wind etc. should be promoted for the energy generation. Basically this energy has very wider and good future scope because they are available in large and unlimited quantity. Solar energy is very large and available in free of cost so it is having good future scope; the power from the sun intercepted by the earth is approximately 1.8×10^{11} MW, which are many thousands of times larger than the present consumption rate on the earth of all commercial energy sources. Thus use of solar energy makes us able to fulfill the present as well as future requirement of the world, without harming the environment because there is no burning of any type of tree coal, wood, petroleum product or any other type of fossil fuel. The main aim to generate energy from solar energy is to conduct the solar radiations coming from the sun and to focus it on generation point. There are many collecting devices like p-n junction solar diode plate, collectors etc. but collectors are the better option because it has greater efficiency as well as less in cost with low maintenance. There are different types of collectors available like flat plate, parabolic dish, parabolic concentrating trough. The parabolic concentrating trough gives more efficiency because of its design, high concentration ratio and less in cost. The design of trough is made such that to concentrate all the solar radiations towards focus point line area, where absorbing copper tube is placed, inside the absorbing coper tube fluid is flowing which is to be heated. Here we are using general water and the distilled water one by one as a working fluid with the purpose to compare the heat transfer rate of both the fluids.

2. Methods and Approach

Generally the setup is consist of a parabolic concentrating trough collector which is use to concentrate the solar rays, it is a type of solar thermal collector that is straight made in one direction line and consist of high reflective mirror or any other material like aluminium sheet with high reflectivity. The sun rays which are entering the parabolic concentrating trough are made to focus on a line where absorbing copper tube is placed.

The most important part of a solar collector is the absorber tube. Generally, this consists of one or more copper sheets which are welded together to make absorbing copper tubes. The absorbing sheets absorb the heat from the sun radiation. Then the heat is transferred to working fluid via copper tubes. A tank is used to collect water which maintains the availability of the working fluid. A rotameter is a measuring device which is used for flow measurement by virtue of which we can measure flow as well as maintain the flow.

Heat exchanger to complete the close cycle by decreasing the temperature to maintain the temperature inside the tank , thermocouples for temperature measurement at various points, and a pump is use to suck water from datum and to circulate the water or working fluid throughout the experimental setup via piping . A pumping device is used to circulate the water with constant flow and pressure to circulate the working medium. All the devices and components should be arranged in a proper manner as shown in the fig. a flow which is required for the setup and to control the flow valve is provided with rotameter which maintains the overall flow of the experimental setup.

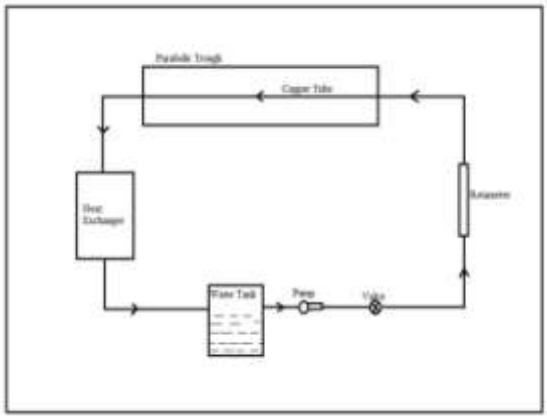

Figure 1

First of all the fluid is allowed to pass through rotameter provided with the flow control valve to maintain the flow. Absorbing copper tube is fitted between the parabolic trough inside which the fluid is made to flow with constant pressure, when the solar rays strikes on the parabolic concentrating trough high reflective surface is use to reflect the rays towards the copper tube, This absorbing copper tube absorbs the solar radiations and fluid flowing inside the tube starts getting heat from radiation. The working fluid which is get heated is than allow to pass through the heat exchanger to decrease the temperature and the fluid is again send back to tank. Thermocouples are used to measure the temperature at different points on the setup and to indicate the change in temperature from starting point to end point of the setup.

First we are using water as a fluid in the absorbing tube; the water is circulated at the constant rate of 2 lit/hr in the tube. The flow is controlled by the rotameter, there are 7 thermocouples are used to measure the temperature at different points. All the readings are taken in a fresh sunny day. As the time goes on passing the temperature seems to be increasing but after a specific time interval it gets decreased.

Again we are repeating the same procedure with same flow rate and time intervals using distilled water instead of general water. Distilled water that has many of its impurities removed through distillation process. Distillation of water generally involves boiling of the water and then condensing the steam into a clean contains to make water distilled.

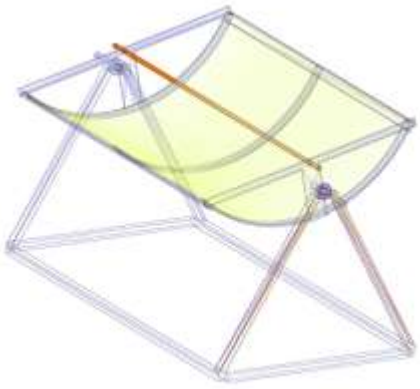

Figure 2: Experimental Setup

3. Conclusion

Hence the design and fabrication of parabolic trough collector is successfully done and the comparative study between normal water and distilled water to calculate the heat transfer rate is also successfully carried out with the help of parabolic trough collector. The different readings of temperature at different point are taken using thermocouple at the time interval of 1 hour. When flow is constant for both the fluids flowing inside the tube we found that heat transfer rate of distilled water is greater as compared to normal water. From the graphs we can easily compare the heat transfer rate of general water and the distilled water. We can easily identify that general water is having less temperature gradient as compare to distilled water which is easily identified by analyzing the graph.

4. Formulae

Renault Number

$R_e = \frac{\rho \times V \times d}{\mu}$

Predult number

$Pr = \frac{\mu \times Cp\,w}{K}$

$N_u = .023 \times R_e^{0.8} \times P_r^{0.3}$

Heat transfer coefficient

$h_{exp} = \frac{\rho water \times V \times A \times Cp\,w\,(T5-T6)}{\pi dl \times (\frac{(T5+T6)}{2} - T7)}$

Area of absorbing tube

$A = \pi/4 \times d^2$

Flow rate $= A \times V$

MASS FLOW RATE

$m = \rho \times A \times V$

HEAT SUPPLIED

$Q = m \times Cp_w \times (T_5 - T_1)$

HEAT REMOVED BY WATER

$Q' = m \times Cp_w \times (T_5 - T_6)$

Table 1: The table is showing the outlet temperature of both the general water and distilled water at proper intervals of time

Time	General water temperature	Distilled water temperature
1o a.m.	40	35
11 a.m.	40	36
12 a.m.	42	40
1 p.m.	43	52
2 p.m.	40	47
3 p.m.	38	46
4 p.m.	39	38
5 p.m.	37	37

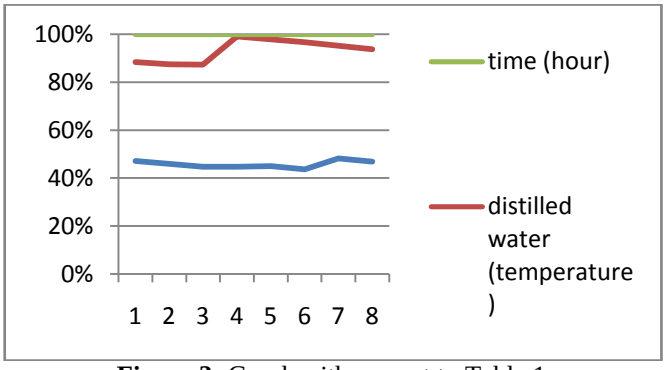

Figure 3: Graph with respect to Table 1

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